AIR POLLUTION*

REPORT BY
THE COMMITTEE ON PUBLIC HEALTH
THE NEW YORK ACADEMY OF MEDICINE

AIR pollution is a product of civilization. Rapid growth in population, industrialization, urbanization with more large cities, extensive automotive transportation: these are the principal underlying and immediate reasons for contamination of the air.

In a report in 1959, the Committee on Public Health of The New York Academy of Medicine enumerated the consequences of air pollution: both an economic loss and a hazard to health. This report stressed the importance of removing pollutants from the air by means of practical control procedures which should be regulated by official action and encouraged by education of the public. It was emphasized that the situation was not good and would inevitably become worse if nothing was done.

In their deliberations the Committee reviewed the then-existing evidence on air pollution and health. This evidence was presented in a companion article prepared by a member of the Committee, Dr. Alvan L. Barach.

The acute effects of extreme cases of air pollution had been dramatically and spectacularly demonstrated by fatalities in London in 1952 and, to a lesser degree, in Donora, Pa., in 1948. About 4,000 deaths were attributed to the five-day episode in London, and the Donora incident had caused much sickness and claimed 20 dead.

Sufferers from respiratory and cardiac diseases had proved to be especially vulnerable during these periods of extreme air pollution. This seemed to indicate that heavy pollution of the atmosphere acted as an additional burden for those with these diseases.

It was less readily demonstrable, however, that chronic effects might be the cumulative result of steady but less pronounced amounts of pollutants. Such a causal relationship was plausible if not presumptive.

Just as difficult of demonstration was the relationship between urban air contaminants and lung cancer. Carcinogenic materials had been found as pollutants in the air, but examination of the evidence tended to suggest that there were many factors involved in the etiology of this disease. Additional studies were indicated to resolve this issue. Since 1959, however, much has happened, both naturally and experimentally, which has provided essential evidence upon which to base an expanded program to combat air pollution.

FURTHER EPISODES AND STUDIES

In October of 1962, Dr. Leonard Greenburg, former commissioner of the New York City Air Pollution Control, published in the *Journal of the American*

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Medical Association his analysis of the relationship of morbidity to an acute period of air pollution which had occurred during November of 1953 in New York City. During this period, persistent surface temperature inversions had resulted in sharp increases in pollution as measured by smoke shade and sulfur-dioxide concentrations. For this study, Dr. Greenburg's staff examined the records at the emergency clinics in four of the major New York City hospitals.

In his survey of pediatric and adult clinic visits, Dr. Greenburg found an increase in upper respiratory illnesses and cardiac ailments at all of the four hospitals studied. This increase was found to be statistically significant at three of the four hospital clinics in upper respiratory infections and two of the four in cardiac illnesses. The study failed to reveal, however, any effects of air pollution on the number of visits for asthma at any of the four hospitals studied.

In a prior review of the same period of high air pollution in New York City, Dr. Greenburg had shown excessive contamination to be related to a significant increase in mortality, especially among individuals suffering from respiratory and cardiac illnesses. The increase had seemed to be generally distributed over all age groups.

In December of 1962 there occurred in London a repeat of the 1952 experience there, a tragic episode of acute air pollution in which 700 people lost their lives. Of the causes of death during the fog and in the following week, the greatest proportionate rise was said to be in bronchitis.

In October of the following year, the northeastern portion of the United States was put on an alert because of meteorological conditions with associated acute episodes of air pollution. Such extreme weather conditions include a reversal of the normal temperature gradient of the atmosphere, in that, contrary to normal conditions, a layer of warm air lies over air which is cooler, thereby forming a "lid" through which pollutants cannot rise. This effect is termed a thermal inversion and, along with decreases in wind velocity and increases in aridity, can create a condition in which pollution may be increased to its maximum intensity.

Such episodes constitute acute periods of air pollution in which there may occur dramatic evidence of its dangers to health through many instances of sickness and death. Fortunately, such an episode did not develop in New York City.

Proof of the chronic effects of air pollution is not, however, as easily demonstrated. Nevertheless, suggestive evidence has been noted. From a study to determine the effects of prolonged exposure to lesser concentrations of pollutants, Zeidberg, Horton, and Landau published in 1963 a comparison of mortality rates for respiratory diseases with atmospheric conditions in Nashville, Tennessee. They showed a lack of correlation between exposure to air pollutants and lung cancer. There were, nevertheless, significantly higher death rates from pneumonia, influenza, pulmonary tuberculosis, and other respiratory infections in the highly polluted areas of the city than in the moderately polluted. The investigators felt that mortality rates for bronchitis and emphysema could not be tabulated in that they were probably prejudiced by the American physician's reluctance to ascribe death to these causes.

Dohan in 1963 reported that his studies indicated a relationship between the susceptibility to and duration of certain respiratory infections, such as the common

cold, and exposure to air contaminants measured as sulfates.

All in all, increasing evidence has provided dramatic confirmation of the dangers inherent in acute atmospheric pollution; furthermore, data linking air contaminants to chronic illnesses are appearing. These developments afford ample justification for an active program to combat contamination of the atmosphere.

Formulation of Standards

Standards for ambient air quality set up in 1959 by the State of California, Department of Public Health, classify three levels of pollution intensity: 1) the "adverse" level at which there will be sensory irritation, damage to vegetation, reduction in visibility or similar effects; 2) the "serious" level at which there will be alteration of bodily function which is likely to lead to chronic disease; and 3) the "emergency" level at which it is likely that acute sickness or death in sensitive groups of persons will occur.

One pollutant which is most consistently marked for control by emission standards is sulfur dioxide. Emitted largely from coal and sour fuels, sulfur dioxide is considered one of New York City's most troublesome pollutants. According to the State of California air-quality standards, this noxious gas is recorded at an "adverse" level at 1 p.p.m. for one hour (or 0.3 p.p.m. for 8 hours), at a "serious" level at 5 p.p.m. for one hour, in which bronchoconstriction is caused in human subjects, and at "emergency" levels at 10 p.p.m. for one hour—this level causes severe distress in human beings.

Experimentation which preceded the setting of standards had progressed along two lines: 1) epidemiological studies involving comparable patterns of community sickness and health in relation to air pollution indices, and 2) laboratory studies of biological damage caused by certain known ingredients of community air supplies.

Regarding the irritant gas sulfur dioxide, epidemiological studies of an impressive nature have been published in England, where sulfurous fuels are widely used. In 1953, Goodman and associates called attention to the geographical distribution of bronchitis in Great Britain, roughly correlating the degree of urbanization and inverse weather conditions to both morbidity and mortality in this disease. In 1958, Reid and Fairbairn published a study on bronchitis in postmen in whom striking differences in susceptibility were related to prevalence of fog, where pollutants were kept close to the earth.

Statistical data on the connection between sulfates in polluted air and disease are not confined to Great Britain. In Yokohama, Japan, a chronic and progressive atypical asthma has become endemic among American military personnel. The habitually negative bacteriological findings, the relief of symptoms when patients are moved out of the area, the heavy industry in the neighborhood, and the smog-producing topography, all point to the polluted atmosphere as the cause for this atypical asthma.

Incidence in "Yokohama asthma" rises when seasonal winds affect high levels of dustfall and SO_2. Laboratory studies indicated that the chemical composition of inhaled dust from Kawasaki (also in the Yokohama area) was similar to that of fly ash. Yokohama asthma was first reported by Huber in 1954, but has since been studied clinically by Phelps, who stated that this condition is chronic asthmatic bronchitis and that it develops rather rapidly into emphysema.

In 1953 Amdur had revealed that sulfur dioxide in concentrations as low as 1 p.p.m. produced shallow rapid respiration and increased pulse rate. It had previously been shown by the same investigator that comparable respiratory changes were produced by sulfuric-acid mist in concentrations as low as 0.35 mg. per cm.

Laboratory experiments involving sulfates and other pollutants have indicated that, among other reactions, sulfur dioxide and other compounds of sulfur may retard the movement of the cilia along the mucous sheath. In 1956, Dalhamn showed that crypts presumably capable of trapping particulates such as soot could be produced in animals by exposure to irritating gases such as sulfur dioxide.

The following year Sim and Pattle exposed normal subjects to sulfur dioxide, sulfuric acid mist, and various aldehydes, and recorded evidence of increased airway resistance, as well as the production of râles with rhinorrhea and lacrimation. Two subjects developed bronchitis symptoms that lasted ten months. The addition of steam, enlarging the size of the particles, increased the irritant effect.

Amdur in 1959 tested the physiological response of guinea pigs to many pollutants, very important of which proved to be the mixtures of gases with aerosols. Of four toxicant gases tested with the inert aerosol sodium chloride, two—sulfur dioxide and formaldehyde—were potentiated, while the other two—acetic acid and formic acid—were not. However, with all four of these gases the presence of the aerosol prolonged the response. This author's data seemed to indicate a synergistic action of the aerosol, when mixed with toxic gases, on an exposed respiratory system.

These laboratory experiments and statistical studies exemplify the work on sulfur dioxide and other irritating gases and particulates associated with diseases. They indicate a real association between several respiratory disturbances and sulfur dioxide. Most importantly such studies enabled the establishment of standards.

Official Action

Federal. As a result of the growing evidence, considerable activity has occurred at all levels of government—federal, state, and municipal—to help overcome this environmental problem.

At a National Conference on Air Pollution held in Washington, D.C., in 1962, more than 1,400 persons gathered, including health officials, engineers, physicians, scientists, legislators, industry spokesmen, and representatives of labor and civic organizations. Their goal was to determine practical methods of closing the gap between the facts known about control of air pollution and the effective application of this knowledge. The third panel session of the Conference was concerned with the effects of air pollution on health. All the participants on the panel concurred in the statement that "the evidence is overwhelming that air pollution contributes to the pathogenesis of chronic respiratory disease. It would be a mistake," they emphasized, "to leave this conference with the impression that there is insufficient evidence for action now. The evidence that air pollution contributes to . . . chronic respiratory diseases is overwhelming."

As an outgrowth of this national concern, the Congress passed the Clean Air Act which the President signed into law on December 17, 1963. This Act replaced Public Law 84-159 passed by Congress in 1955. The earlier law had authorized a maximum appropriation of $5 million for each of 5 fiscal years; subsequent amend-

ments and acts had extended the time period for the appropriations. But no substantive change had been allowed since 1955 in the authority of the Public Health Service to take action against air pollution offenders.

The new Clean Air Act gives the Federal Government authority to prosecute such offenders where the problem is interstate in character, or where called in by a particular state for intrastate pollution abatement. Like the Federal Air Pollution legislation which it replaced, however, this Act recognizes that the primary responsibility for the regulatory control of air pollution rests with states and local government.

The Clean Air Act authorizes the Federal Government to provide financial assistance to state and local governments for the creation or improvement of air pollution control programs. Its principal provisions are: 1) to initiate and support an expanded national program of research and development in the field of air pollution control; 2) to award grants-in-aid to help local, state, and regional air-pollution control agencies to initiate, expand, or improve their programs; and 3) to take action to secure the abatement of specific air pollution problems that are endangering the public health or welfare.

The Act authorizes appropriations of funds totaling $95 million, but not to exceed $5 million for the first year, $25 million for the second, and $30 and $35 million for the successive two years of its operation. It singles out two of the major unsolved air-pollution problems for special attention—motor-vehicle exhaust and pollution from fuels containing sulfur.

State. At the state level, control over air pollution is legislated in 33 states and territories, while 18 have no legislation. Fifteen states have some control authority, while 12 have only local option legislation. Depending upon the exact meaning given the word "enforcement," it may be said that four to six states "enforce" air pollution regulations.

In the 17 states having programs in 1961, the average annual expenditures for air pollution control was only 2 cents per capita. The total full-time personnel employed for such work was 148, with 29 others engaged on a part-time basis. More common state activities were development of local programs with technical assistance to personnel.

It has been estimated that the number of personnel in local air pollution control agencies increased about one third between 1952 and 1961. There were 37 more local agencies in 1961 than in 1952; but outside of new agencies in California, only five of these employed more than two people. Also, during that period, five local agencies were discontinued.

Nine states have adopted laws which authorize cities or counties to operate air pollution control agencies with authority transcending municipal boundaries. The San Francisco Bay Area Air Pollution Control District is a good example of such action; this agency serves 89 urban places of various sizes.

California has perhaps made more progress in the establishment of air pollution control programs than any other state. In 1961, 57 per cent of a total national expenditure of $2 million was spent by California. It has pioneered the establishment of air quality and emission standards as well as standards for motor vehicle emissions. Seven states have followed suit and have authorized the establishment of standards.

As previously mentioned, California has formulated standards classifying three

levels of pollution intensity. New York State is in the process of setting standards for air quality and also for emissions from some industrial installations. Such plans call for approval of the installations by the State Air Pollution Control Board or by qualified local agencies. New York, as well as some other states, has also enacted legislation requiring the use of the blow-by device on automobiles. Such a device is meant to prevent emissions in the range of 30 per cent from escaping from the crankcase. The automobile industry is installing these blow-by controls on all new models, but the fumes from cars manufactured before 1963 remain to be checked.

Action on the local level has been enhanced in New York State by creation of Action for Clean Air Committees. The main purpose of these committees is to acquaint the public with the magnitude and scope of the problem of air pollution, together with the methods for correcting or controlling it.

Municipal. The New York City Department of Air Pollution Control has recently recodified its rules and regulations, which will be known in the future as the Air Pollution Control Code. The most substantive change made in this revision was the shifting of emphasis from the regulation of named air contaminants emitting from specific sources to the regulation of air contaminants in general from whatever source.

New York City air pollution officials are also cooperating in a study of national air-quality standards, on the basis of those followed by California. Scientifically valid air-quality standards are based upon confirmed data relating the level of exposure to air pollutants and resultant effects in sensitive or other defined groups in the population. As a result of such standards, definite amounts of emissions from various sources of pollution will be determined.

Within the American Standards Association, industry's plans for self-policing of effluent air and gas-cleaning equipment failed to bring results. According to Commissioner Benline of the New York City Air Pollution Control:

> It was unfortunate and quite regrettable that the Z74 sectional committee project was abandoned last year. Standardization must come in this field and the lack of concentrated effort is costing the nation a lot of money. I know American standards for air pollution criteria would help. Better still, they would remove some of the confusion that's crept into the minds of many on how to measure contamination, and then reduce it.

Residents complain most about incinerators, possibly because their emission of smoke, fly ash, and odors makes them a nuisance and their closeness attracts attention to them. But in terms of volume they contribute only 2 to 3 per cent to air pollution. Nevertheless, air pollution from this source should be reduced. Commissioner Benline has stated that most incinerators in New York are archaic and inferior. Several European cities have incinerators that operate on principles that promote efficiency. There, large municipal incinerators, located in the heart of the city with residences and schools adjacent to them, operate without visible air pollution or nuisance. This central location permits the heat to be utilized by nearby buildings. The residue after incineration is used in road construction. Models just as efficient can be built in this country. But a good incinerator costs more than an inferior one; too often price is the deciding factor. It should be noted that the Department has established criteria for construction of an incinerator.

The Committee's Deliberations and Conclusions

The Committee recognized that eradication, or even substantial lowering of air pollution, will require a long-range plan with multiple actions, considerable time, and money. Meanwhile, however, remedial and protective steps can be taken. After a thorough review of the present status, the Committee deemed it advisable to consider first the means by which a private citizen could protect himself during an emergency period of air pollution. It has been demonstrated that the irritant effects of sulfur-dioxide gas and sulfuric-acid mist are neutralized and their irritant effects abolished by adding ammonia gas to the atmosphere. The Committee pointed out that a simple method of personal protection during acute periods of air contamination would be to neutralize sulfur dioxide by an appropriate method, e.g., with a suitable alkaline solution, applied within a room by a vaporizer or atomizer. It was noted that studies would be necessary to ascertain the required concentration of alkaline solution for adequate neutralization, commensurate with comfort of the individual. It was believed that the same principle could be applied to air conditioners and humidifiers by means of filters containing the neutralizing solution. Variations based on this principle were found to be helpful in London during periods of heavy fog. The Committee believed that research on this method of self-protection merited high priority.

Sim and Pattle noted that dry sulfuric acid mists were well tolerated by most individuals, but that wet mists of larger-particle size with high humidity produced irritancy. Repeated exposure to the latter mist led to a persistent bronchitis in one subject. In light of these observations, the Committee was of the opinion that the possible hazard of operating humidifiers in homes during an emergency period of pollution should be more fully investigated. Until future evidence establishes its safety, it was concluded that operation of a humidifier during an emergency period should be regarded as a presumptive danger and the public should be warned of it.

The Committee also considered official action to protect the citizen. Since the present weight of evidence indicates that sulfur dioxide is definitely detrimental to human welfare and may even cause obvious tissue damage, the Committee concluded that the use of fuel oils high in sulfur and also the use of bituminous coal should be prohibited in the Air Pollution Code.

In the judgment of the Committee, air pollution should be considered on a regional basis since each community is a microcosm with its own particular irritants and particulates. New York City is a potential trouble spot from air pollution. It has had periods that could have led to disaster. Thus far it has been most fortunate in escaping heavy fatalities from acute episodes. But chance is not a very dependable source of protection. New York City has every reason to encourage and support steps to control pollution and to engage in research on still unsolved problems.

But the situation in this city is critical. Though the Department of Air Pollution Control is charged with the heavy responsibility of protecting the health of millions of New York residents and additional millions of visitors, it lacks trained personnel and funds needed to carry on its activities. Furthermore, much of its equipment is old. Facing a crisis in its essential daily operations, the Department cannot be expected to carry on adequately and effectively in providing protection to the health of the citizens.

In the opinion of the Committee, the need for intensified research on a number of problems should be emphasized. It pointed out the gap in knowledge concerning many of the issues preceding control of pollutants. Some of these areas were enumerated:

1. The effects of nitrogen oxides on health should be determined.
2. The possible relation of the presence of carcinogens in air to the presence of cancer should be further studied and documented.
3. Experimentation should be augmented concerning the effect of continued air pollution in moderate concentrations on chronic disease patterns.
4. A good method should be sought for removal or lowering of sulfur from fuel oil.
5. The need for more complete combustion of gasoline by automobiles should be re-emphasized and research encouraged. Development of the blow-by device was a step forward. For complete combustion of remaining gas in the tailpiece, the after-burner appears to hold most immediate promise. Perhaps other solutions to the problem may be found.

The Committee was cognizant that some research is being conducted in most of the above-named areas, but it believes that information from such studies is important enough to warrant more active experimentation.

RECOMMENDATIONS

In view of the revealing experiments and studies which implicate certain air pollutants as hazards to health, the Committee made the following recommendations:

1. Efforts should be continued to provide proper planning for the regulation of industrial emissions, including the application of existing devices for control of pollutants. Such planning should include the setting of ambient-air quality standards. Appropriate laws should then be enacted for the maintenance of these standards, with sufficient authority for their enforcement.
2. In New York City the use of fuel oils containing a high concentration of sulfur and the use of bituminous coal should be prohibited in the Air Pollution Control Code.
3. Meanwhile the Department of Air Pollution Control should sponsor research on a simple method of protecting citizens during a period of emergency levels of pollution, based on the principle of neutralizing sulfur dioxide by means of an alkaline solution expelled in a room by a vaporizer. After studies have been conducted determining the proper concentration, this procedure should be widely publicized to citizens for use in the event of an acute period of air pollution.
4. The presumptive danger of operating a humidifier during a period of emergency contamination should also be widely publicized.
5. Research should be continued on the possible effects of nitrogen oxides on health. The presence of carcinogens in the air and their possible relation to the production of cancer should be more thoroughly studied. The possible effects of continuous but moderate air contamination on the production of chronic disease, as well as the possible hazard which such concentrations of pollutants present to those persons who already suffer from chronic illnesses, should be more extensively studied.

6. There should be continued research on reducing the sulfur content of fuel oil.

7. Important also is the elimination of exhaust fumes from automobiles. To this end experimentation should be advanced to find an effective low-priced afterburner for combustion of noxious gases within the tailpiece of motor vehicles.

8. Every effort should be made to strengthen the Department of Air Pollution Control of New York City in order to enable it to conduct adequately its day-to-day operations.

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